Missouri Department of Natural Resources
Water Protection Program

Total Maximum Daily Loads (TMDLs)

for

Main Ditch
Butler County, Missouri

Completed: October 24, 2005
Approved: December 19, 2005

Total Maximum Daily Loads (TMDLs)
For Main Ditch
Pollutants: Biochemical Oxygen Demand, Volatile Suspended Solids, Low Dissolved Oxygen

Name: Main Ditch

Location: Near Poplar Bluff in Butler County, Missouri

Hydrologic Unit Code (HUC): 11010007-070005

Water Body Identification Number (WBID): 2814

Missouri Stream Class: C[1]

Beneficial Uses:
- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life
- Protection of Human Health associated with Fish Consumption
- Irrigation

Use that is impaired: Protection of Aquatic Life

Size of Impaired Segment: 5 miles

Location of Impaired Segment: From the center of Section 10, T23N, R6E (downstream) to SE Section 15, T24N, R6E (upstream)

Pollutants: Biochemical Oxygen Demand (BOD), Volatile Suspended Solids (VSS), low Dissolved Oxygen (DO)

Pollutant Source: Poplar Bluff Wastewater Treatment Plant

Permit Number: Missouri State Operating Permit No. MO-0043648 [2]

TMDL Priority Ranking: High

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[1] Streams that may cease flow in dry periods but maintain permanent pools which support aquatic life. See Missouri Water Quality Standards (WQS) 10 CSR 20-7.031(1)(F). The WQS can be found at the following uniform resource locator (URL): http://www.dnr.mo.gov/env/wpp/rules/index.html#Chap7
[2] The state permitting system is Missouri's program for administering the National Pollution Discharge Elimination System (NPDES) program.

1.0 Background and Water Quality Problems

1.1 Area History[3]

The earliest permanent settlements in what is now Butler County occurred in the early 1800's along the Natchitoches Trail, an old Native American trail west of what now Poplar Bluff on Ten Mile and Cane creeks. Butler County was officially established February 27, 1849. It was formed from the lower half of Wayne County, which was too big to meet the needs of its citizens. The southern boundary of Butler County is the state of Arkansas and the east boundary is the St. Francis River. The new county was named for a Kentuckian, General William O. Butler. Besides being a well-known military leader and a lawyer, General Butler was a farmer, public leader and politician. He was the Democratic nominee in 1848 (the year before the county was formed) for vice-president, on the ticket with Lewis Cass. They were defeated by Zachary Taylor and Millard Fillmore. The people of the county chose an uninhabited bluff on the Black River for their county seat. They named it Poplar Bluff for the poplar trees that grew there in abundance.

1.2 Geography

Main Ditch begins where Pike Creek drops off the Ozark Plateau and becomes a "boot-heel" ditch (see Figure 1). Prior to 1907, southeast Missouri (the boot-heel) was all swampy lowlands and Pike Creek ran into the swamp. In 1907, the Little River District was formed to drain the swamp for farming. Main Ditch is part of the drainage network.

1.3 Soils and Land Use

The soils in the Main Ditch watershed are in the Calhoun-Amagon association, which are nearly level, poorly drained, silty soils on low terraces and flood plains. The soil along the impaired portion consists mostly of the Amagon and Calhoun series, which are characterized by slow permeability and slopes ranging from 0 to 2 percent.

Land use in the impaired section of Main Ditch and the watershed as a whole is mostly agricultural row crop. The Poplar Bluff wastewater treatment lagoons discharge to Main Ditch.

1.4 Defining the Problem

Main Ditch is on the 2002 303(d) list due to high Biochemical Oxygen Demand (BOD), Volatile Suspended Solids (VSS), and low Dissolved Oxygen (DO). High BOD and VSS cause low dissolved oxygen in the receiving stream, which eliminates many aquatic organisms that require high levels of oxygen to survive.

1.4(a) Source Analysis: Point Source Component

In 1988, three wastewater treatment lagoons serving Poplar Bluff were combined into one, which currently receives all the city's wastewater. This lagoon empties directly into Main Ditch. As a result of this wastewater discharge and other human activities dissolved oxygen (DO) levels in Main Ditch are below state water quality standards (WQS). DO is not a pollutant and cannot be allocated in a TMDL. BOD is the parameter used to determine the impact that wastewater will cause on DO levels in a receiving stream. There is no numeric criterion in the Missouri water

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[3] http://poplarbluff.org/admin/welcome.html
http://www.butlercogenealogy.com/history_of_butler_county.htm
http://poplarbluff.org/history/html/names.html

quality standards for BOD. Since DO cannot be allocated, but does have a numeric criterion, DO is linked to BOD. BOD is a measurable pollutant and may be allocated in a TMDL.

BOD is composed of carbonaceous oxygen demand (CBOD) and nitrogenous oxygen demand (NBOD). NBOD is estimated directly from Total Kjeldahl Nitrogen (TKN), which is ammonia nitrogen (NH_3-N) plus organic nitrogen and Nitrate (NO3) plus Nitrite (NO2). State water quality standards for all Missouri streams, except cold water fisheries, call for daily minimum of 5 milligrams per liter (mg/L or parts per million) dissolved oxygen 10 CSR 20-7.031(4)(J) or the natural upstream concentration of dissolved oxygen as determined on a regional or watershed basis, 10 CSR 20-7.031(4)(A)(3). The data in Table 1 was used to summarize the BOD and estimated load from the Poplar Bluff treatment facility discharge monitoring reports (DMRs) during July and August.

Main Ditch is also listed for Volatile Suspended Solids (VSS). VSS are organic solids wastewater treatment facilities produce. The presence of a high level of VSS is probably more attributable to the treatment facility effluent than other sources.

Poplar Bluff Wastewater Treatment Facility (WWTF) is the only discharger in the impaired segment's watershed. The current permit (MO-0043648) has a design flow of 2.9 million gallons per day (MGD) (about 4.5 cubic feet per second [ft^3/s]) and contains the following effluent limits: BOD_5 30/45 mg/L monthly/weekly averages respectively, TSS 80/120 mg/L, NH3 10 mg/L, and a pH >= 6 standard units. A copy of the permit is attached (Appendix D). The permit expired July 30, 2003. The monthly DMRs summary for the period of January 1999 to March 2004 is presented in Table 1a. These reports show that the median lagoon discharge is 8 ft^3/s, the average is 10 ft^3/s and its upper 95^{th} confidence interval is 10.5 ft^3/s. This is about twice the design flow. BOD_5 is the amount of oxygen used to decompose the organic matter present in a water sample in a five-day period. The BOD_5 concentration and estimated load for July and August are summarized in Table 1. The discharge in this calculation is the overall monthly average of all flows reported for April through October (10 ft^3/s,Table 1b).

Table 1a: Estimated BOD_5 load for July and August based on DMR data

Year	Month	BOD_5 concentration (mg/L)	Kg/day	(lb/day)
1999	July	27	662	1,457
1999	August	23	564	1,241
2000	July	47	1,152	2,536
2000	August	30	735	1,619
2001	July	15	368	809
2001	August	29	711	1,565
2002	July	23	564	1,241
2002	August	25	613	1,349
2003	July	28	686	1,511
2003	August	76	1,862	4,100

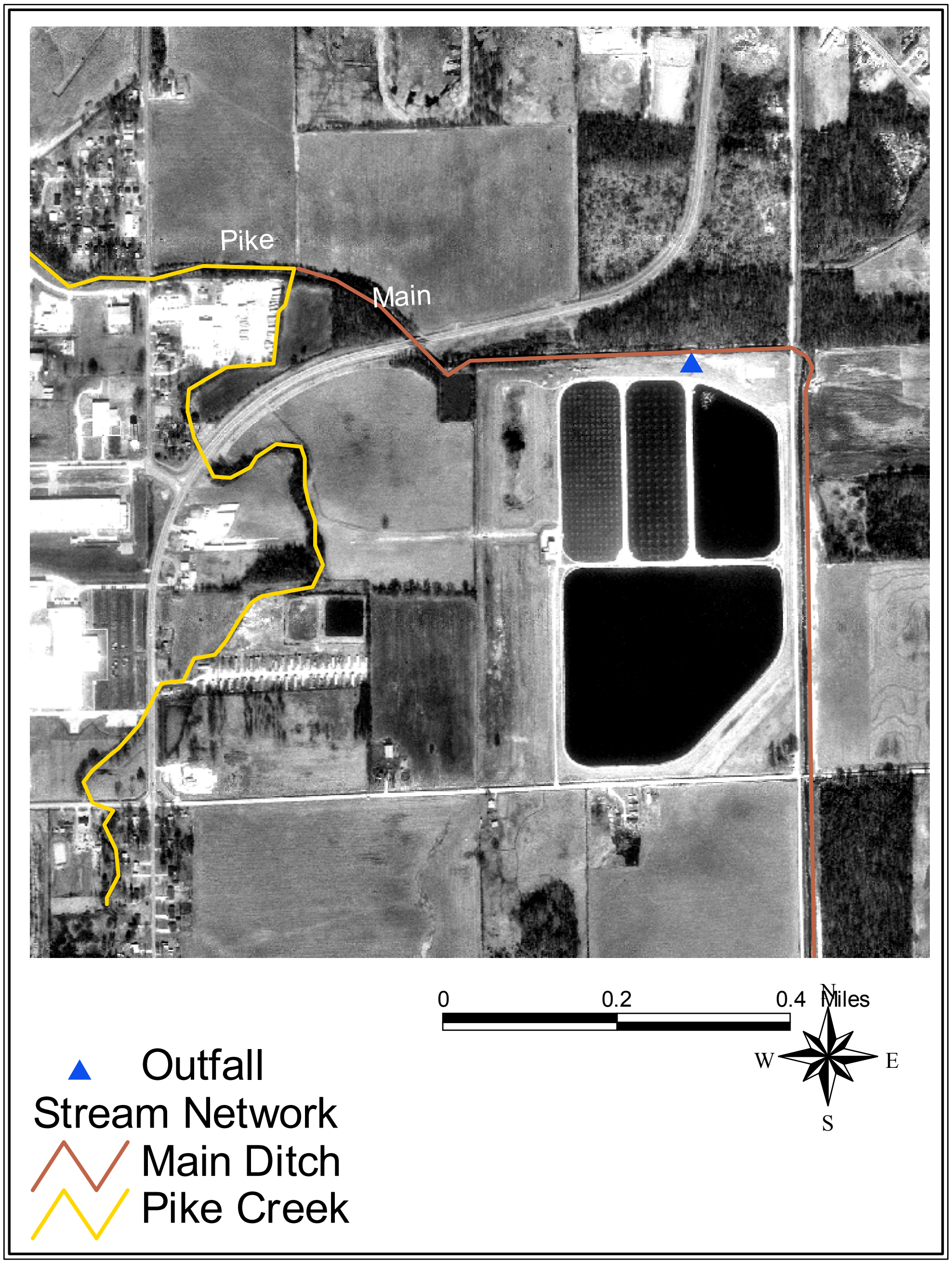
Table 1b: Flow (ft^3/s) Summary of DMR Data for the period 2001 – 2003

Month	Average of minimum	Average of maximum	Monthly Average
Apr	7.0	16.0	11.5
May	8.0	17.7	12.8
Jun	5.3	12.0	8.7
Jul	5.7	11.3	8.5
Aug	6.3	12.0	9.2
Sep	5.7	13.0	9.3
Oct	5.3	10.3	7.8
Overall Average			9.7 (rounded to 10)

1.4(b) Source Analysis: Nonpoint Source Component

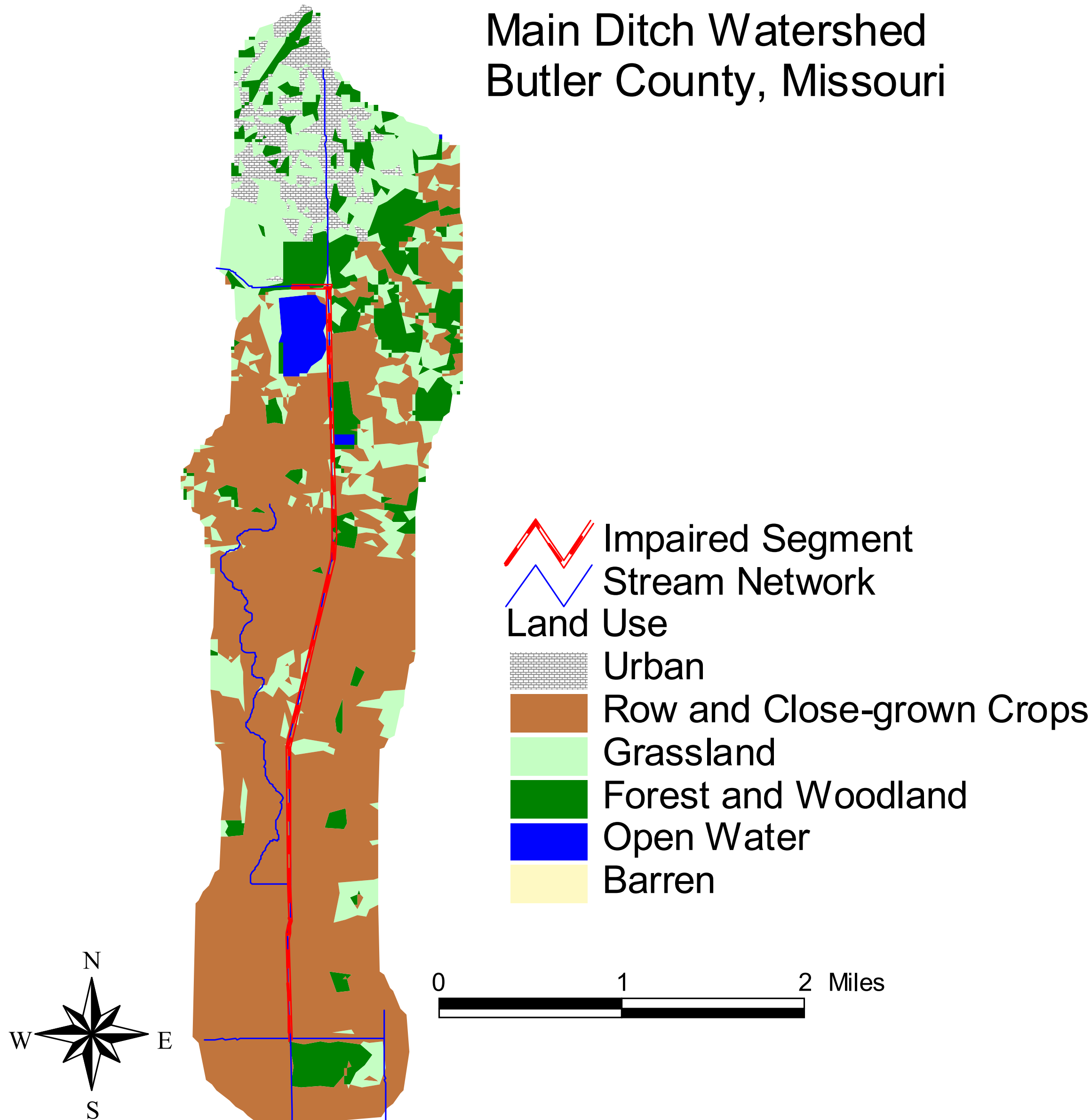
The nonpoint source in this watershed consists of runoff from agricultural fields during rain events. Because row cropping is the major farming activity in the watershed, the runoff is suspected to carry sediment, nutrients and ammonia.

Figure 1: Partial DOQQ[4] showing the outfall and stream network near the lagoon



[4] The Digital Orthophoto Quarter Quadrangle (DOQQ) is a computer-generated image of an aerial photograph with 1-meter ground resolution.

Figure 2: Land Use Categories in Main Ditch Watershed



Land_use	Acres	Sq_miles	Percentage
Urban	231	0.36	5.6
Row and Close-gro	2539	3.97	61.8
Grassland	778	1.22	18.9
Forest & Woodland	494	0.77	12.0
Open Water	68	0.11	1.7
Barren	0	0.00	0.0
Total	4109	6.00	100.0

2.0 Description of the Applicable Water Quality Standards and Water Quality Targets

2.1 Designated Uses

The designated uses of Main Ditch, WBID 2814, are:

- Livestock and Wildlife Watering,
- Protection of Warm Water Aquatic Life,
- Protection of Human Health associated with Fish Consumption, and
- Irrigation.

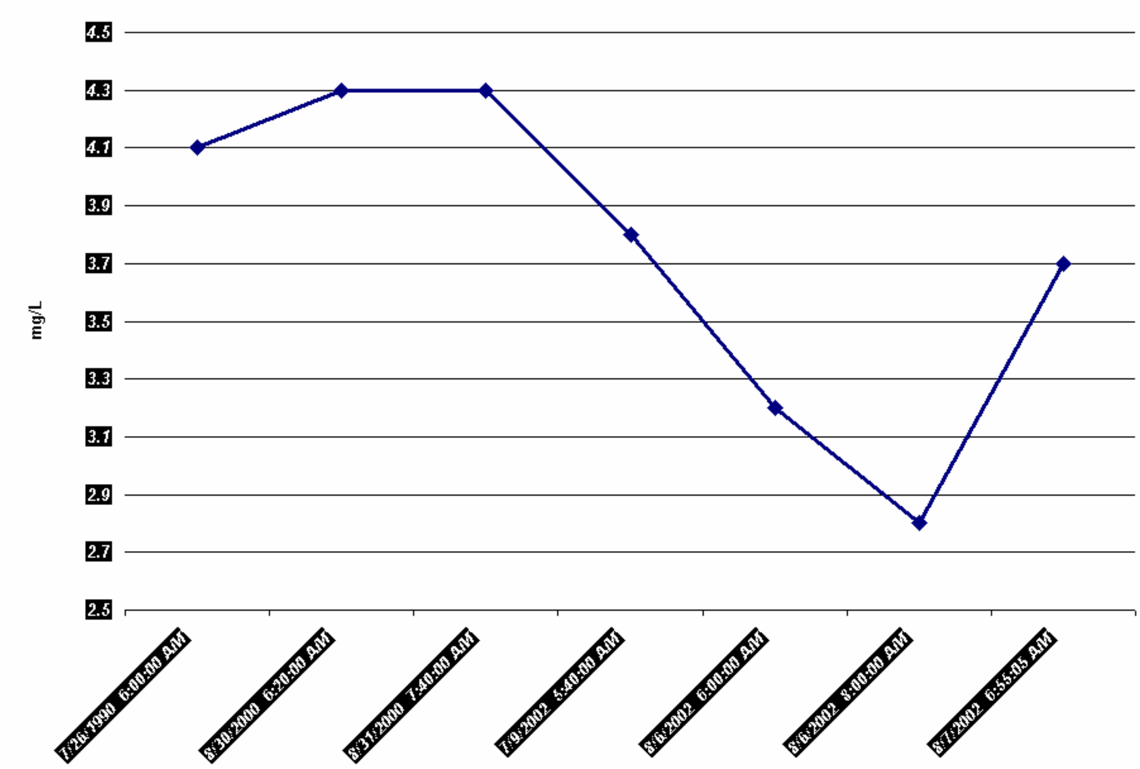
The use that is impaired is the Protection of Warm Water Aquatic Life. Waterbody classification definition and designated uses are in 10 CSR20-7.031 (1)(C) and 10 CSR20-7.031 Table G, respectively.

2.2 Standards that apply

Main Ditch is at best considered a limited warm water fishery. Early morning background dissolved oxygen concentration in Main Ditch upstream of the outfall was consistently below 5 mg/L. The average DO concentration in this segment is 3.8 mg/L and the maximum is 4.3 mg/L (Figure 3). It is evident that a man made drainage ditch lacks the characteristics of a natural stream. A ditch is a long narrow excavation of the earth. It is a straight furrow that usually has a constant slope. Because of its unique morphology, a ditch does not have riffles and pools. Consequently, its water lacks choppiness and has a lower aeration coefficient than a natural stream. It is therefore appropriate to allocate a suitable minimum DO concentration for Main Ditch instead of the general standard of 5 mg/L. However, currently Missouri water quality standards, albeit they allow for site specific consideration (10 CSR 20-7.031 (4) (A) 3), do not provide an approved implementation policy or protocol. For this reason, target DO concentration in Main Ditch is set at 5 mg/L.

The City of Poplar Bluff, during the public notice period, requested that “site specific criteria” be applied because it is their belief that the DO concentrations above the outfall are consistently below the 5 mg/L DO criterion. The City would like to apply for a variance from the WQS and attempt to document the natural condition of the stream through monitoring and ultimately develop site-specific criteria for DO. If a scientifically defensible analysis demonstrates a site-specific criteria change is warranted, Missouri can revise and adopt the WQS based upon the analysis, and submit the WQS revisions to EPA for approval. If EPA approves the site-specific criteria revision, the TMDL can be reopened and the allocations revised to reflect the WQS change in regard to the site-specific dissolved oxygen criteria. Unless the above described WQS process has been completed and approved by EPA, Poplar Bluff’s NPDES permit must be reissued with the Waste Load Allocation derived permit limit concentrations identified in this TMDL for BOD, VSS and ammonia.

Figure 3: Background Morning Dissolved Oxygen Concentration.



- The Missouri Water Quality Standard (10 CSR 20-7.031 Table A) for dissolved oxygen is greater or equal to 5.0 mg/L for limited warm water fishery.
- Although Main Ditch is not listed for ammonia, total ammonia criteria for limited warm water fishery are 2.0 and 3.3 mg/L for summer and winter respectively (10 CSR 20-7.031 Table A). These values are based on a pH of 7.8 and a temperature of 26 and 6^{o} C for summer and winter receptively. Because ammonia nitrification requires oxygen, the model must account for such oxidation.
- The criterion for VSS is covered under the general criteria section of the WQS (10 CSR 20-7.031(3)(A) and (C)). The narrative criteria state that:
  - "Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent full maintenance of beneficial uses.
  - Waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor or prevent full maintenance of beneficial uses."

Note: Any waterbody that was listed for Non-Filterable Residue (NFR) in 1998, such as Main Ditch, is now being listed as Volatile Suspended Solids (VSS). This change was made to better distinguish between organic solids coming from wastewater treatment plants (VSS) and mineral solids (soil or mineral particles) coming from soil erosion or erosion of mine waste materials or stockpiles (Non-Volatile Suspended Solids or NVSS).

2.3 Anti-degradation Policy

Missouri's Water Quality Standards include the U. S. Environmental Protection Agency (EPA) "three-tiered" approach to anti-degradation, and may be found at 10 CSR 20-7.031(2).

Tier 1 – Protects existing uses and provides the absolute floor of water quality for all waters of the United States. Existing instream water uses are those uses that were attained on or after November 29, 1975, the date of EPA's first Water Quality Standards Regulation, or uses for which existing water quality is suitable unless prevented by physical problems such as substrate or flow.

Tier 2 – Protects the level of water quality necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water in waters that are currently of higher quality than required to support these uses. Before water quality in Tier 2 waters can be lowered, there must be an antidegradation review consisting of: (1) a finding that it is necessary to accommodate important economical or social development in the area where the waters are located; (2) full satisfaction of all intergovernmental coordination and public participation provisions; and (3) assurance that the highest statutory and regulatory requirements for point sources and best management practices for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the "fishable/swimmable" uses and other existing uses.

Tier 3 – Protects the quality of outstanding national resources, such as waters of national and state parks, wildlife refuges and water of exceptional recreational or ecological significance. There may be no new or increased discharges to these waters and no new or increased discharges to tributaries of these waters that would result in lower water quality (with the exception of some limited activities that result in temporary and short-term changes in water quality).

3.0 Loading Characteristics and Corresponding Stream Water Quality Response

3.1 Biochemical Oxygen Demand

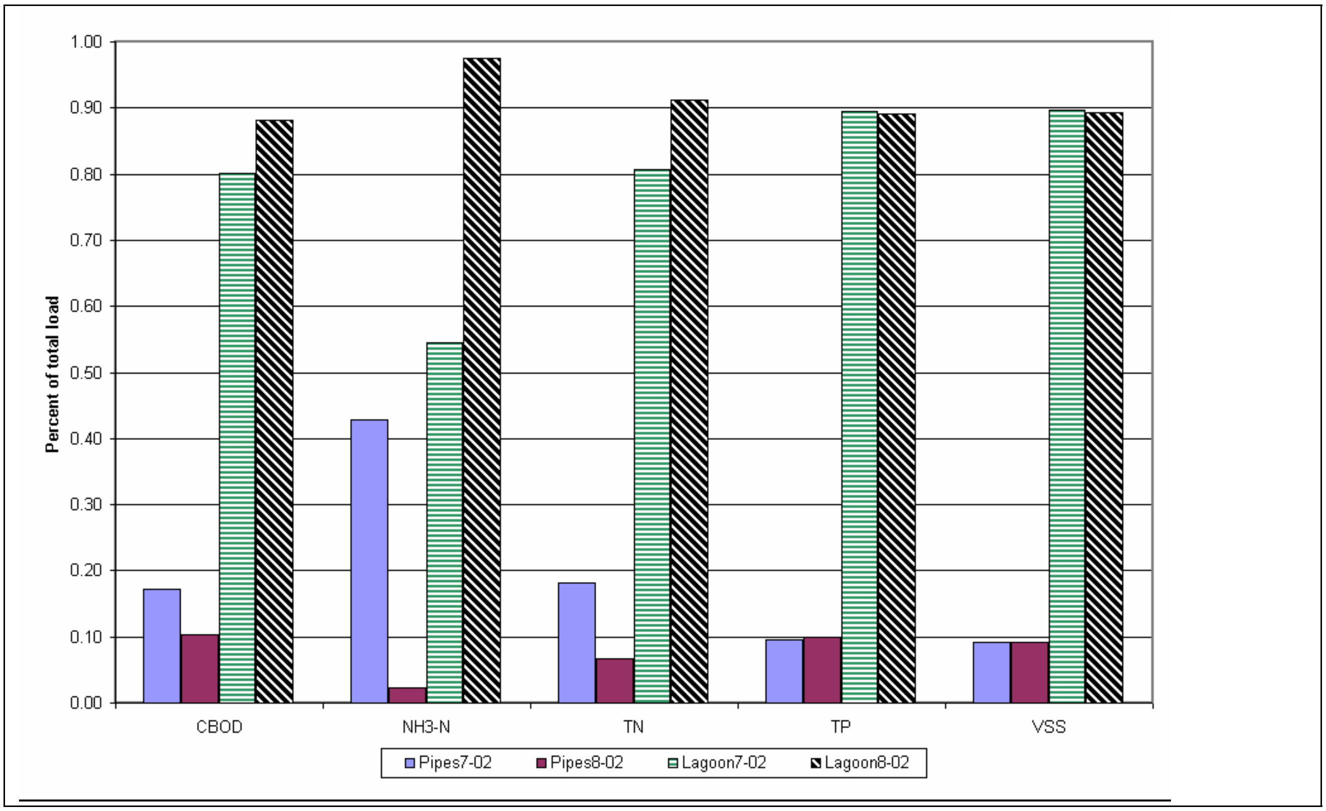
Dissolved oxygen in water is depleted and renewed through several processes. BOD reflects the amount of oxygen consumed through two processes: carbonaceous biochemical oxygen demand and nitrogenous biochemical oxygen demand. CBOD is the reduction of organic carbon material to its lowest energy state, CO_2, through the metabolic action of microorganisms. NBOD is the term for the oxygen required for the biological oxidation of ammonia to nitrate, called nitrification. BOD_5 is the amount of oxygen used to decompose the organic matter present in a water sample in a five-day period.

Sediment oxygen demand (SOD) is a combination of several processes. Primarily it is the decay of organic materials that settle to the bottom of the stream.

The pollutant load to Main Ditch is mostly from the lagoon discharge. The load from the irrigation return flow through the drainage pipes accounted for 18 and 10 percent of total CBOD in July and August 2002, respectively (Figure 3). Similarly, ammonia nitrogen load represented 40 and 2 percent of the total load. The data shows that pollutant loads from the pipes are much higher in July than in August. This fact is probably due to land management and crop fertilization practices in the watershed. It is common for farmers in this region to mix fertilizers with irrigation water during the growing season to boost crop production.

CBOD load measured in July of 2002 was about 20 percent higher than that of August of the same year. This is probably due to slightly higher loads of total nitrogen and ammonia in July. In August 2002, 98 percent of the ammonia-nitrogen load and 81 percent of total nitrogen load originated from the lagoon discharge. These numbers indicate that lagoon discharge is the major polluter of Main Ditch (Figure 4).

Figure 4: Comparison of percentage loads grouped by source (July and August 2002).

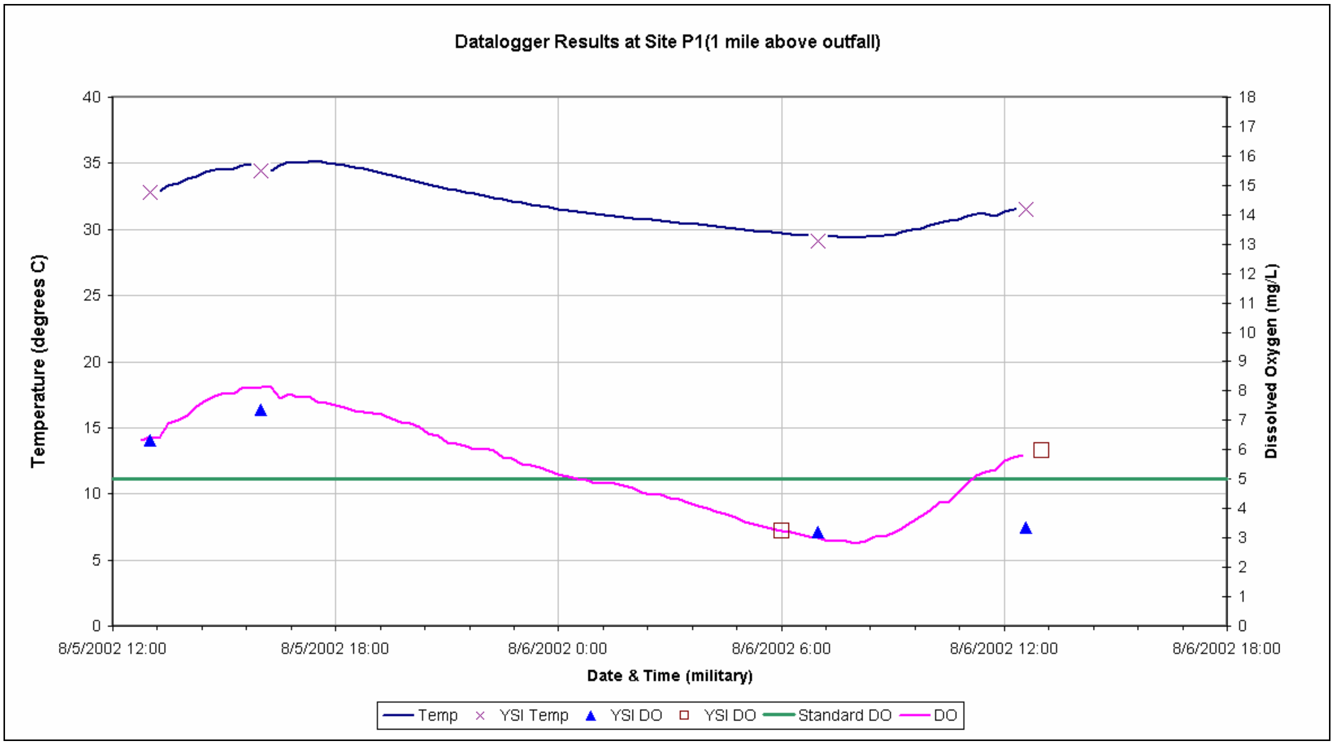


3.2 Instream loading

Two headwaters[5] are simulated in the model. Main Ditch and an unnamed tributary to Main Ditch that empties downstream of the outfall. The tributary is usually dry in the summer, and thus has no significant effect in this calculation. During precipitation events, the tributary collects drainage from the southern outskirts of the city of Poplar Bluff. However, during all stream surveys, the tributary was dry, and thus had no contribution to Main Ditch. Main Ditch headwater flow consists primarily of a diverted portion of Pike Creek flow at a point half a mile upstream of the outfall (Figure 5).

[5] Headwaters are the small streams from which a river originates.

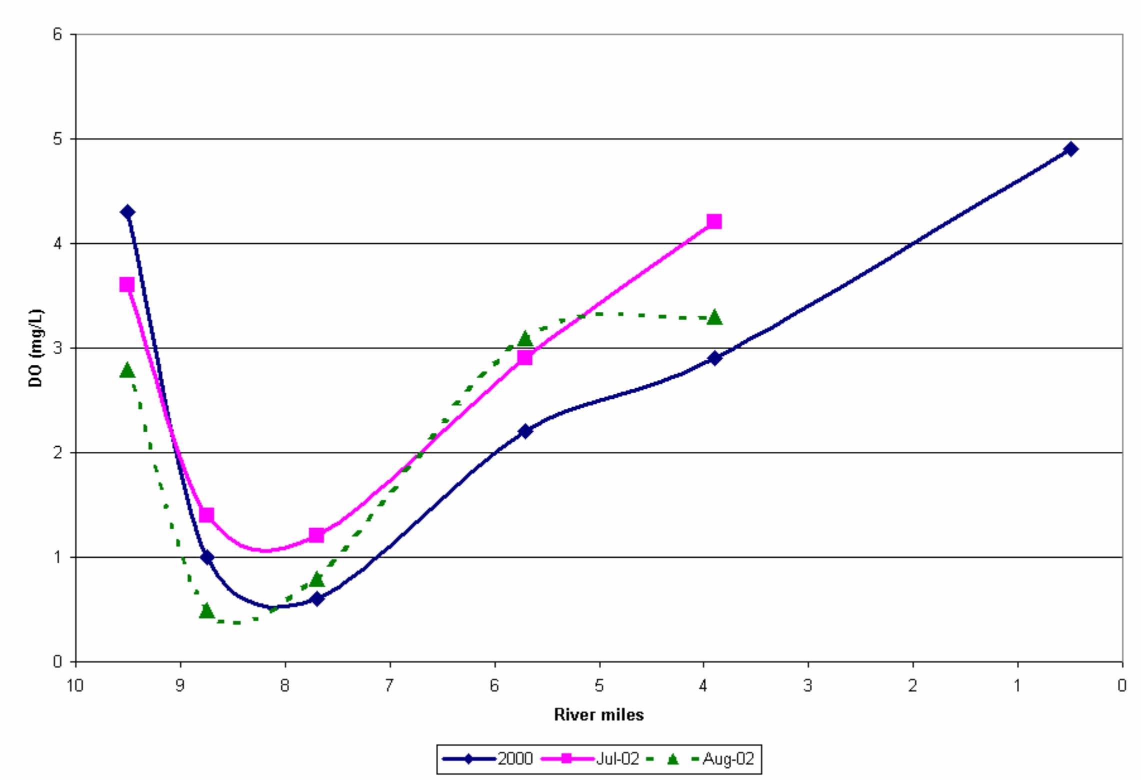
Figure 5: Temperature and Dissolved Oxygen Fluctuation in the Headwater



3.3 Dissolved Oxygen Response

On August 6, 2002, dissolved oxygen (DO) concentration dipped blow 5 mg/L from 45 minutes after midnight until 11 a.m. The lowest concentration (2.8 mg/L) was registered at 8 a.m. Low DO concentration and its duration and frequency hamper the normal development of aquatic life and limit their diversity. Only relatively tolerant species may survive under low DO conditions. Adequate dissolved oxygen is necessary for good water quality. Oxygen is a necessary element to all forms of life. Natural stream purification processes require adequate oxygen levels in order to provide for aerobic life forms. As dissolved oxygen levels in water drop below 5.0 mg/L, aquatic life is put under stress. The lower the concentration, the greater the stress. Oxygen levels that remain below 1-2 mg/L for a few hours can result in large fish kills. Minimum dissolved oxygen is illustrated in Figure 6.

Figure 6: Minimum Dissolved Oxygen in Main Ditch.



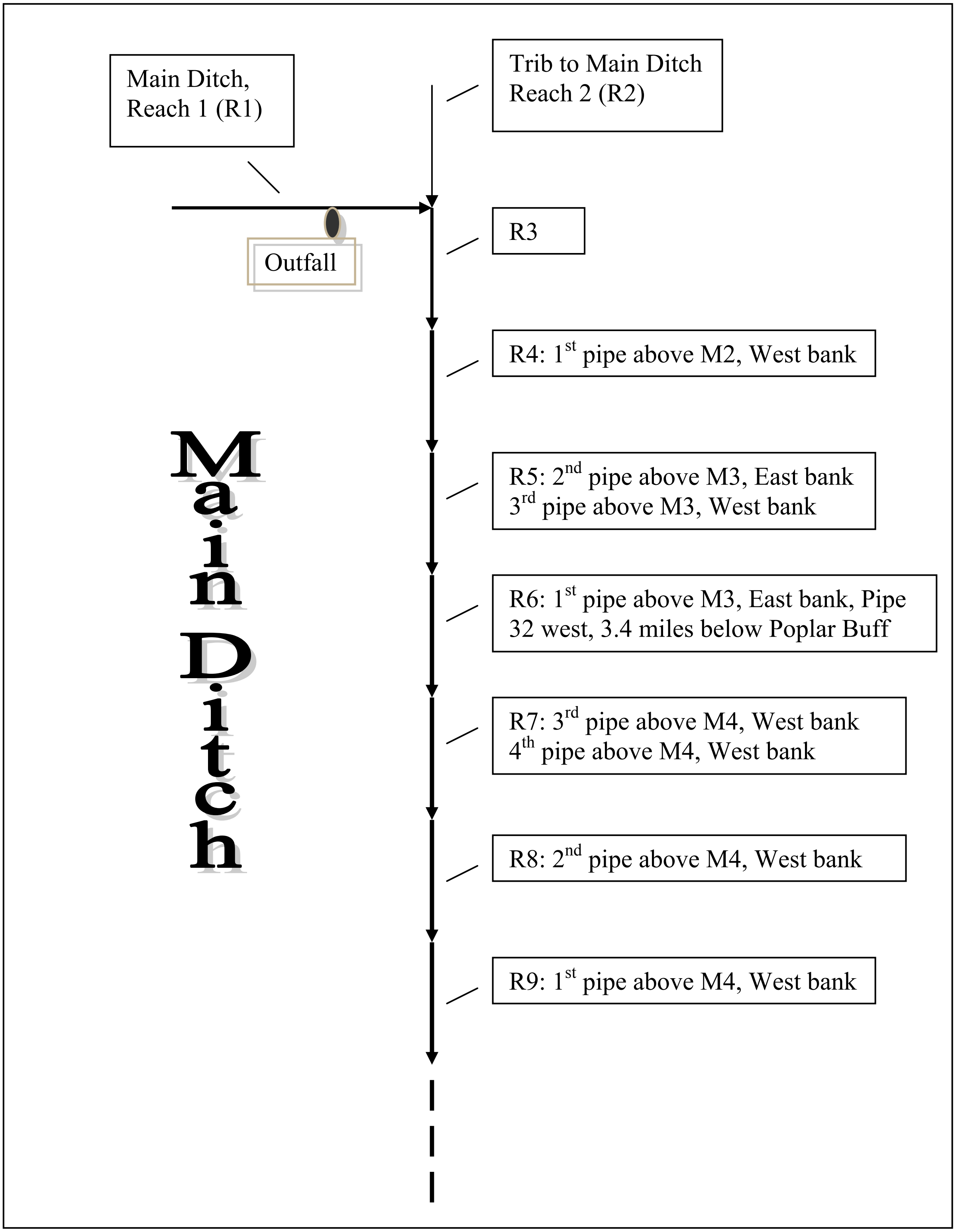
The lagoon outfall is located at river mile 9. For all three data sets, DO concentration reached its minimum at a point downstream of the outfall. Comparing these minimum values to the initial DO above the outfall, it appears that the wastewater discharge is responsible for up to 86 percent reduction in dissolved oxygen [(upstream DO – downstream DO)/upstream DO].

4.0 TMDL Development and Modeling Approach

4.1 Analysis of Discharge and Load Contribution

Main Ditch receives discharge from the Poplar Bluff WWTF (lagoon system) and from many irrigation drainage pipes. The flow and water quality from these drainage pipes are variable and difficult to quantify accurately. The drainage pipes discharge during the wet season, rain events and during the dry season, when farmers irrigate their crops. The emphasis is to model the dry season because it is the critical period for aquatic life survival. Any runoff due to irrigation waters alone is conceptually represented in the model as a point source. It is logical to assume that irrigation takes place only when it is not raining. The available water quality data were collected during low flow periods and are used to calibrate the model. To represent the load contributions from all sources in a steady state model (Qual2e), drainage pipes within a reach were grouped and treated as one point source. A total of six point sources were added to Reachs 4 through 9 (Figure 7). The lagoon's outfall is in Reach 1(R1).

Figure 7: Schematic presentation of the modeled segment of Main Ditch (July 2002, Survey)



The objectives of this strategy are:

(a) to determine the load capacity of the system,
(b) to account for all load contributors, and
(c) to allocate loads to each source, in particular the lagoon system.

These components are quantitatively related to each other as represented in the following formula:

$$TMDL = LC = \Sigma WLA + \Sigma LA + MOS$$

Where:

TMDL = total maximum daily load - usually expressed in mass/time.
LC = loading capacity, or the greatest loading a waterbody can receive without violating water quality standards.
WLA= wasteload allocation, or the portion of the TMDL allocated to existing or future point sources.
LA= load allocation, or the portion of the TMDL allocated to existing or future non-point sources and natural background, and
MOS= margin of safety, or an accounting of uncertainty about the relationship between pollutant loads and receiving water quality. The margin of safety can be provided implicitly through analytical assumptions or explicitly by reserving a portion of loading capacity.

Loads are computed according to the equality expression below:
Load (lb/day) = flow (ft^3/s) x concentration (mg/L) x 5.395 (conversion factor) or, based on SI[6], kg/day = ft^3/s x mg/L x 2.45.

4.2 Calculation of Load Capacity of Main Ditch (LC)

For the purpose of this calculation and the resulting implementation, discharge from the drainage pipes, albeit they are identifiable and modeled as point sources, are in reality nonpoint sources. These pipes are not regulated or permitted under the National Pollutant Discharge Elimination System (NPDES). Accordingly, the load capacity (LC) contains the three basic components as shown below:

- **Load Allocation (LA):**

  The load allocation (LA) is the maximum allowable amount of the pollutant that can be assigned to nonpoint sources. Because of the timing of data collection, only discharge from the irrigation pipes is represented. As shown in Table 2, LA contribution is relatively small when compared to that of the lagoon system.

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[5] Système International d'Unités (international system of units based on the Meter, Kilogram, Second, Ampere, Kelvin, Candela, and Mole)

- **Wasteload Allocation (WLA):**

The wasteload allocation (WLA) is the maximum allowable amount of the pollutant that can be assigned to point sources. The only component of WLA in this case is Poplar Bluff's lagoon. Because Main Ditch is a Class C stream at the outfall, lagoon effluent qualifies for a mixing zone as allowed in the Missouri water quality standards 10 CSR 20-7.031 (4) (A) 5. Only acute criteria apply within the mixing zone. However, chronic criteria must be achieved at the edge the mixing zone.

Early morning (before 7 AM) dissolved oxygen concentrations of the effluent have an average of 6.2, a median of 6.6, a minimum of 1.5, and a maximum of 10.1 mg/l. The model used an effluent DO concentration of 5 mg/L. It is anticipated that ammonia criteria would necessitate an upgrade from the current lagoon to a mechanical plant. If this takes place, the new plant would most likely produce effluent with a higher dissolved oxygen level.

VSS was not simulated in the model. Its WLA was derived through statistical calculations of available data. The 25th percentile value of all VSS data is 2.499. Since the detection level for this pollutant is 5 mg/L, a no detection measurement is reported in the database as 2.499 to allow numerical computation. The 2.499 equals the detection level value (5) divided by 2 minus 1 plus 0.099 [no-detection = 5/2 – 1 + 0.099]. The 99 at the end, is a flag to indicate no detection. The VSS target was conservatively set to 5 mg/L.

The WLA concentration limits for CBOD and NH_3-N are identified in Table 2.

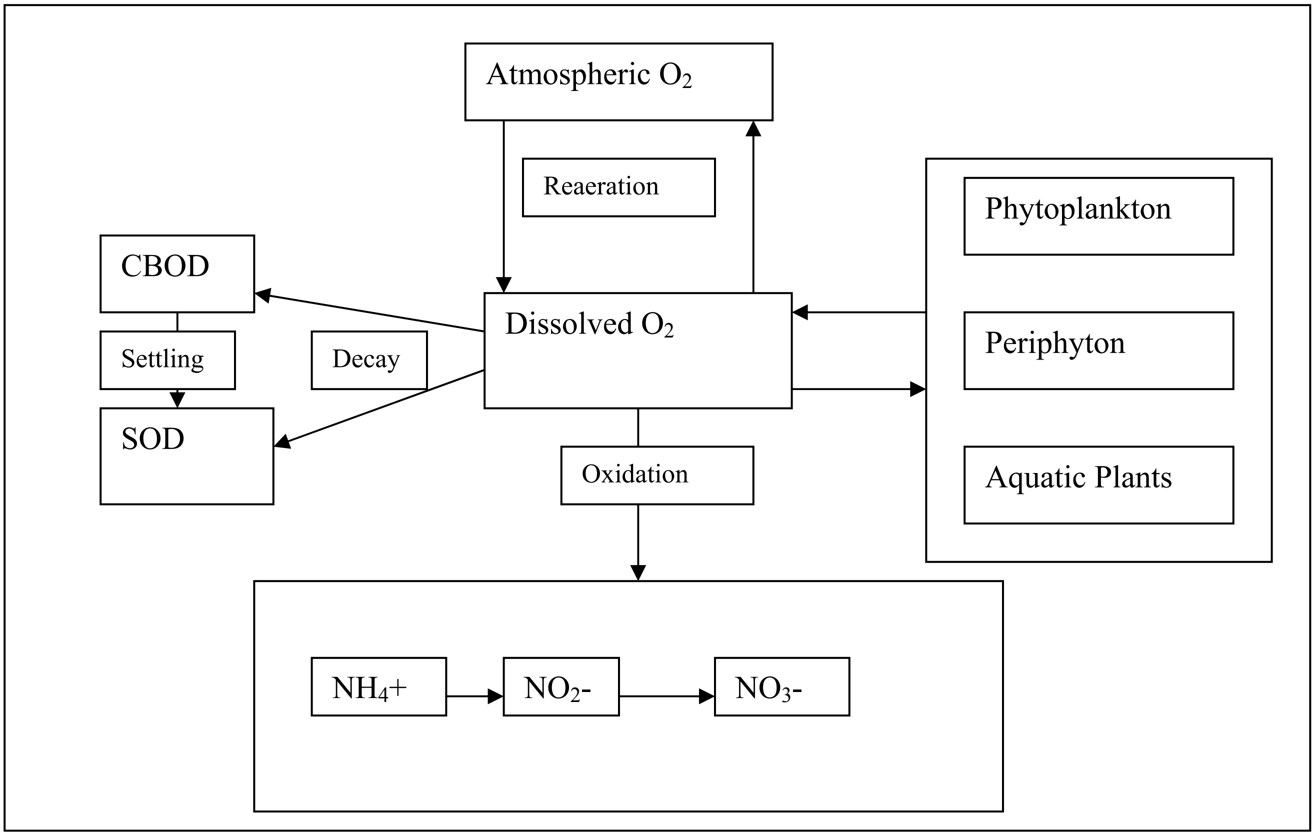
- **Margin of Safety (MOS):**

The MOS is implicit and is expressed three ways. First, the use of early morning dissolved oxygen data to calibrate the model. In the early hours of the morning, dissolved oxygen concentration is at its lowest. Maintaining a 5 mg/L DO concentration during this critical period ensures achieving water quality standards all day. Second, stream surveys took place during the low flow and high temperature season (July and August). These severe conditions are the exception, thus they have a low occurrence probability. Third, the simulation considered a background DO concentration of 1 mg/L instead of the lowest recorded levels of 4.3, 3.6, and 2.8 mg/L for August 2000, July 2002, and August 2002 respectively.

4.3 Additional Facts

The instream data show high pH values (above 9 SU). As pH value increases, ammonia becomes more toxic to aquatic life; consequently, ammonia criterion becomes more stringent. Because of this fact and its demand for oxygen, ammonia was modeled even though Main Ditch was not listed for ammonia. Total ammonia nitrogen standard is based on a pH of 7.8 standard units. Thus, lagoon discharge must be maintained in the legal range for the derived limits to be protective of water quality standards.

The load capacity in this stream is simulated to assure a minimum acceptable dissolved oxygen concentration. Dissolved oxygen dynamics depend on the interactions of several constituents and processes. These constituents include dissolved oxygen, carbonaceous biochemical oxygen demand, nitrogenous biochemical oxygen demand (ammonia and nitrite), temperature, phytoplankton, periphyton, and aquatic plants. Figure 8 depicts the processes affecting dissolved oxygen.



As previously indicated, Main Ditch is listed as impaired only for low DO, high BOD and VSS concentrations. However, because ammonia nitrification requires oxygen, the model must account for such oxidation. Total ammonia chronic criteria that apply to Main Ditch (limited warm water fishery) are 2.0/3.3 mg/L for summer/winter respectively. These values translate to 1.7 and 2.75 mg/L when expressed in Total Ammonia-Nitrogen (NH_3-N).

4.4 Model Assumptions and Predictions

The discharge from the irrigation return pipes was modeled as a point source. The 2002 estimated stream flow was adjusted to reflect a normal increase as the water moves downstream. The adjustment parallels the trend of the flow measured in August 2000 and is consistent with the professional judgement of stream surveyors.

Because the facility has been operating above capacity in the last five years as indicated in the DMR data, the modeling simulation results are based on an average actual flow of 10 ft^3/s.
Summer and winter runs are summarized in Table 2.
During all the surveys (July 2000, July and August 2002) there were only discharges from the lagoon and the drainage pipes. In the winter simulations, it is assumed that no field irrigation takes place and the lagoon generates all loading. Winter simulation assumes an average air temperature of 6 degrees Celsius (about 43^o F) and a headwater flow of 0.1 ft^3/s (7Q10 value).
The waste load allocation for BOD developed for the low flow period should apply all year long. The rational for this recommendation is that if a wastewater treatment facility is able to achieve these limits during one season, it should be able to realize the same accomplishment all year long. In addition, there were no data available to estimate non point source contribution to BOD loading during the winter season. In conclusion, operating the plant to maintain a constant performance will reduce any sludge-like accumulation on the ditch floor.

Table 2: Summary of Main Ditch Loading Capacity

Summer Point Sources	Flow (ft3/s)	CBOD (mg/L)	CBOD Load (lb/day)	NH3-N (mg/L)	NH3-N Load (lb/day)	VSS Load (lb/day)
WWTP	10	20	1079	1.7	67	270
Pipes-Reach 4 (LA 4)	0.9	6	29	0.025	0.09	24
Pipes-Reach 5 (LA5)	0.6	3.5	11	0.065	0.15	16
Pipes-Reach 6 (LA 6)	0.4	2.3	5	3.2	5.06	11
Pipes-Reach 7 (LA 7)	0.3	0.99	2	0.02	0.02	8
Pipes-Reach 8 (LA 8)	0.32	0.99	2	10	12.64	9
Pipes-Reach 9 (LA 9)	0.95	4	21	0.02	0.08	26
Subtotal	3.47		69		18	94
Load Capacity			**1148**		**85.19**	**363**
Winter						
WWTP	10	20	1079	2.8	110.60	270

The nonpoint source load or LA from the return pipes is reported in Table 2 as measured in the field. It is quite possible that better farming practices will reduce this loading to the stream.

5.0 Implementation

The Poplar Bluff NPDES permit shall set water quality based effluent limits, which shall be derived from this TMDL. To reduce the loading and the effect of ammonia and total nitrogen on the impairment of Main Ditch, efforts should be made to educate and encourage farmers to adopt best management practices (BMPs). BMPs are recommended methods, structures, or practices designed to prevent or reduce water pollution. The concept of BMPs is a voluntary and site specific approach to water quality problems. In the Main Ditch watershed, BMPs should focus on irrigation timing, fertilizer management, and crop rotation. The department will work with the NRCS and the local Soil and Water Conservation District to solicit their help in forming a watershed group with the stakeholders. The following BMPs would be applicable to reducing pollutants to Main Ditch:

- Irrigation, when poorly managed, may cause environmental problems by transporting pesticides, nutrients and sediment to drinking water supply. BMPs for the use of irrigation can help increase efficiency and uniformity and reduce contamination of water resources. Irrigation best management practices include irrigation scheduling, equipment modification, land leveling, tail-water recovery, proper tillage and residue management. Irrigation scheduling should be based on soil moisture content, soil field capacity and plant water need.

- Fertilizers complement the soil's nutrient and mineral resources necessary for plant growth, health and productivity. The level of fertility of the soil and the crop needs, are the best indicators of what, how much, and when to fertilize.

- Crop rotation is the succession of at least two different crops on the same parcel of land. The best rotation contains crops of different families (graminea and legumenae) that have different needs and different rooting systems. Such rotation allows efficient use of the soil profile, breaks the life cycle of crop specific pests, and requires less pesticides and fertilizers. Legumenae, through symbiotic relationship with soil bacteria (Rhizobium[7]), enriches the soil in nitrogen. This symbiosis can relieve the requirements for added nitrogenous fertilizer during the growth of the leguminous crop.

6.0 Continuous Monitoring Plan

Periodic effluent and stream monitoring of at least dissolved oxygen, pH, temperature, ammonia, biological oxygen demand, and volatile suspended solids will validate the adequacy of this calculation. In addition, low flow stream survey and biological assessment shall be performed one to two years following treatment facility construction and TMDL implementation to properly link stream water quality and biocriteria to the proposed effluent limits and the BMP activities in the watershed. The department routinely (about every five to seven years) monitors small streams that receive wastewater effluent from facilities that discharge at least 1 million gallons per day.

7.0 Reasonable Assurances

The department has the authority to write and enforce Missouri State Operating Permits, which should provide reasonable assurance that instream water quality standards will be met. The

[6] Bacteria of genus rhizobium (Rhizobium Legminosarum) induces nitrogen-fixing nodules on the roots of legumes.

department will work with the City of Poplar Bluff to discuss treatment plant upgrades and funding options and will issue a permit reflective of the water quality standards that must be met. The department will work with local groups to educate them on BMPs that are more protective of Main Ditch.

8.0 Public Participation

This water quality limited segment is included on the approved 2002 303(d) list for Missouri. The Missouri Department of Natural Resources, Water Protection Program, developed this TMDL. The public notice period was from August 5, 2005 to September 4, 2005. Groups that received the public notice announcement included the Missouri Clean Water Commission, the Water Quality Coordinating Committee, Stream Team volunteers in the watershed (21 people), the appropriate legislators (Senator Robert Mayer, Representative Gayle Kingery, Representative Mike Dethrow, and Representative Otto Bean) and others that routinely receive the public notice of Missouri State Operating Permits. A copy of the notice, comments received and the department responses have been placed in the Main Ditch file.

9.0 Appendices

Appendix A – Topographic Map of the Impaired Segment with Sampling Sites
Appendix B – Discharge Monitoring Report (DMR) Data Summary
Appendix C – Water Quality Data – 1974 to 2002

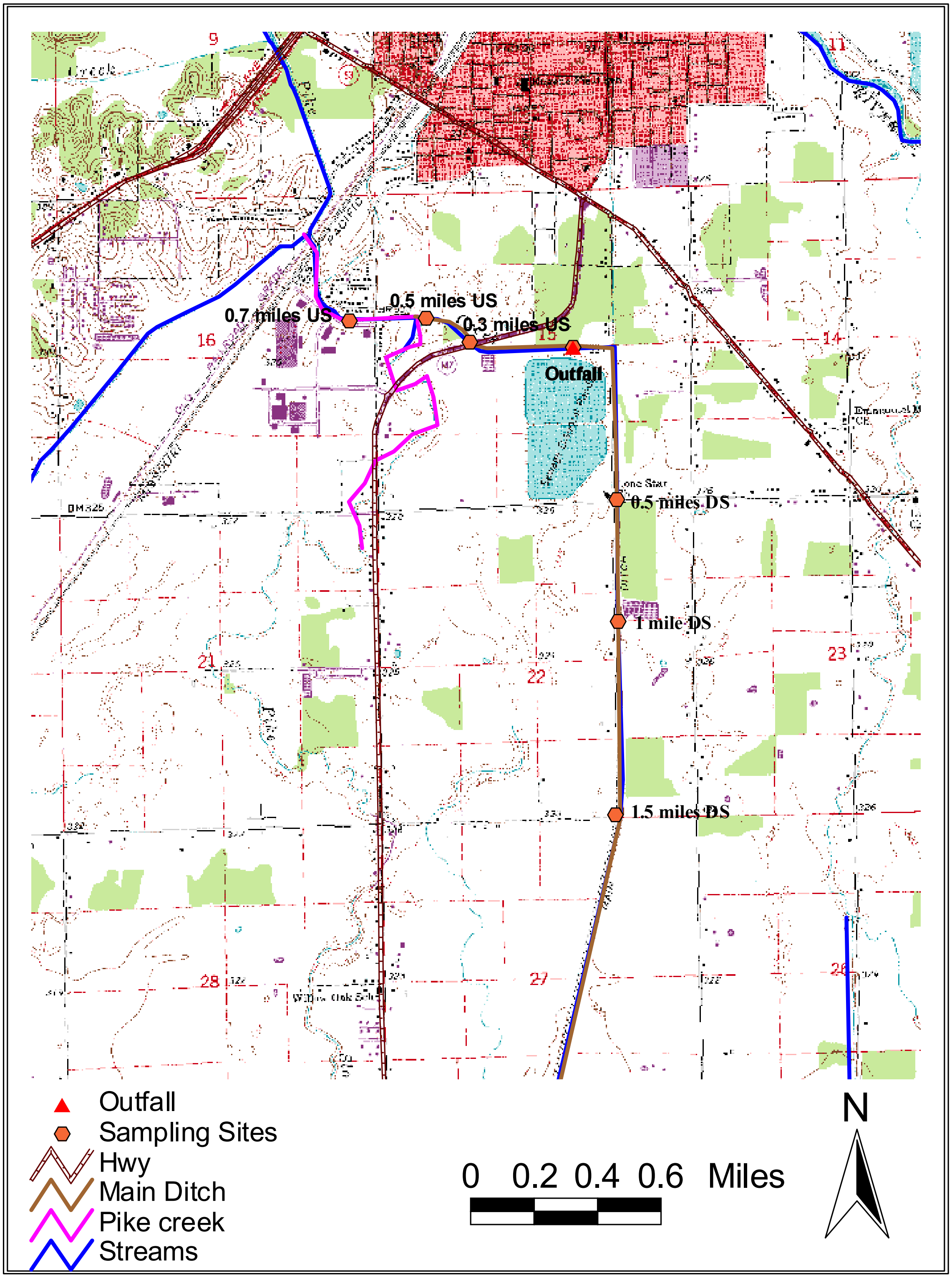
10.0 Administrative Record and Supporting Documentation

An administrative record on the St. Francis River TMDL has been assembled and is being kept on file with the Missouri Department of Natural Resources. It includes the following:

Two Department Water Quality Surveys - July 2000, July and August 2002
Qual2e model inputs/outputs for both summer and winter runs
Main Ditch Information Sheet
Public Notice announcement
Public comments and department responses

Appendix A

Map showing monitoring sites in relation to the outfall on Main Ditch in Butler County, Mo



Appendix B: Discharge Monitoring Report (DMR) Data Summary

Date	Flow ft3/s Avg	Flow ft3/s Max	BOD5 Avg	BOD5 Max	TSS Avg	TSS Max	NH3T Avg	NH3T Max	pH Min	pH Max
1/31/1999			23	28	21	26	5	5	6.0	7
2/28/1999			22	30	29	39	6	6	6.0	6.9
3/31/1999			22	31	36	45	8	8	6.0	7.6
4/30/1999			19	22	24	31	6	6	6.0	6.9
5/31/1999			16	19	26	33	11	11	6.0	6.9
6/30/1999			26	32	27	37	5	5	6.0	7.0
7/31/1999			**19**	**27**	29	47	3	3	6.0	7.6
8/31/1999			**19**	**23**	29	37	7	7	6.0	8.0
9/30/1999			15	21	28	35	5	5	6.0	8.0
10/31/1999			36	55	34	49	4	4	6.0	7.3
11/30/1999			41	45	34	43	4	4	6.0	7.0
12/31/1999			31	48	31	38	6	6	6.0	7.2
1/31/2000			20	33	27	36	10	10	6.0	7.2
2/29/2000			26	33	35	47	14	14	6.0	7.2
3/31/2000			22	40	26	36	7	7	6.0	7.0
4/30/2000			26	27	44	51	3	3	6.0	7.8
5/31/2000			37	41	43	51	5	5	6.0	6.9
6/30/2000			22	35	35	50	5	5	6.0	7.1
7/31/2000			**33**	**47**	38	50	5	5	6.0	8.0
8/31/2000			**20**	**30**	37	57	1	1	6.0	8.6
9/30/2000			26	41	76	178	1	1	6.0	8.5
10/31/2000			27	40	45	100	3	3	6.0	7.0
11/30/2000			8	12	11	13	15	15	6.0	7.0
12/31/2000			16	21	10	13	17	17	6.0	7.3
1/31/2001	5	16	20	31	13	22	12	12	6.0	7.1
2/28/2001			21	39	7	9	7	7	6.0	6.7
3/31/2001	8	17	11	21	4	6	11	11	6.0	7.0
4/30/2001	6	17	17	22	12	20	9	9	6.0	7.1
5/31/2001	5	8	28	51	20	24	9	9	6.0	8.2
6/30/2001	5	8	18	26	25	32	1	1	6.0	8.7
7/31/2001	**6**	**12**	**11**	**15**	39	63	1	1	6.0	8.8
8/31/2001	**6**	**11**	**23**	**29**	42	51	1	1	6.0	8.9
9/30/2001	5	9	22	26	41	62	1	1	6.0	9.0
10/31/2001	6	12	30	34	41	58	1	1	6.0	7.1
11/30/2001	6	22	23	36	24	28	1	1	6.0	7.0
12/31/2001	9	26	41	57	27	35	3	3	6.0	6.8
1/31/2002	5	9	21	28	16	20	5	5	6.0	6.9
2/28/2002	6	17	16	21	11	17	9	9	6.0	6.8
3/31/2002	11	23	28	50	9	16	5	5	6.0	7.0
4/30/2002	9	14	31	55	19	29	6	6	6.0	7.2
5/31/2002	11	23	39	89	22	32	2	2	6.0	6.8
6/30/2002	6	16	14	17	27	38	0	0	6.0	8.2
7/31/2002	**5**	**6**	**17**	**23**	33	56	0	0	6.0	9.2
8/31/2002	**5**	**9**	**21**	**25**	34	41	2	2	6.0	9.1
9/30/2002	6	14	26	37	33	44	1	1	6.0	8.2

10/31/2002	5	11	29	55	36	55	0	0	6.0	7.5
11/30/2002	6	12	33	36	50	53	0	0	6.0	7.4
12/31/2002	8	31	45	67	40	59	10	10	6.0	7.3
1/31/2003	6	26	20	24	17	19	9	9	6.0	7.4
2/28/2003	8	16	25	27	14	20	5	5	6.0	7.2
3/31/2003	8	16	30	35	27	52	4	4	6.0	7.2
4/30/2003	6	17	15	23	11	19	13	13	6.0	7.1
5/31/2003	8	22	21	33	14	17	12	12	6.0	6.5
6/30/2003	5	12	19	30	24	35	1	1	6.0	8.0
7/31/2003	**6**	**16**	**17**	**28**	22	36	2	2	6.0	7.3
8/31/2003	**8**	**16**	**49**	**76**	39	54	4	4	6.0	6.8
9/30/2003	6	16	32	45	34	45	0	0	6.0	7.1
10/31/2003	5	8	27	33	25	38	1	1	6.0	7.0
11/30/2003	8	25	32	42	18	20	1	1	6.0	6.8
12/31/2003	8	17	27	46	17	20	9	9	6.0	7.2
1/31/2004	8	9	34	64	15	16	9	9	6.0	7.7
2/29/2004	9	16	25	40	13	17	9	9	6.0	7.1
3/31/2004	0	0	39	40	17	28	7	7	6.0	7.0

Appendix C: Water Quality Data – 1974 to 2002

Site Name	Yr	Mo	Dy	Time	Flow	DO	KJN	NH3N	NO3N	TN	TP
Main Ditch near Neelyville	1974	11	26	855	32	9	1.4	0.55	0.42	1.8	0.95
Main Ditch near Neelyville	1975	1	28	850	12	7.6	1.9	1.3	0.48	2.4	1.1
Main Ditch near Neelyville	1975	3	18	850	60	8.2	1.4	0.41	0.37	1.8	0.55
Main Ditch near Neelyville	1975	5	21	900	10	6.8	0.61	0	0.01	0.6	0.37
Main Ditch near Neelyville	1975	7	17	910	3.8	7	3.47	0.57	0.03	3.5	0.85
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	1990	7	25	1727	0.2	5.9					
Pipe 53W, 3.0 miles below Poplar Bluff WWTP	1990	7	25	1800	1.5	9.7					
Poplar Bluff Lagoon Effluent	1990	7	26	700	1.3	7		5.1	0.06		
Pipe 53W, 3.0 miles below Poplar Bluff WWTP	1990	7	26	629		3.5		3.4	0.59		
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	1990	7	26	600		4.1		0.02	0.025		
Main Ditch-Pike Cr. confluence	1992	9	1	600		1.8		4.4	0.51		
Pipe 32W, 3.4 miles below Poplar Bluff WWTP	1992	9	1	640		1.5		3.9	0.06		
Main Ditch 3.8 miles below Poplar Bluff lagoon outfall	1992	9	1	640		1.5		3.9	0.06		
Main Ditch-Pike Cr. confluence	1992	9	2	745		1.7		4.31	0.58		
Pipe 32W, 3.4 miles below Poplar Bluff WWTP	1992	9	2	730		2.7		2.95	0.06		
Main Ditch 3.8 miles below Poplar Bluff lagoon outfall	1992	9	2	730		2.7		2.95	0.06		
Main Ditch-Pike Cr. confluence	1992	9	3	730		2.2					
Pipe 32W, 3.4 miles below Poplar Bluff WWTP	1992	9	3	745		3.7					
Main Ditch 3.8 miles below Poplar Bluff lagoon outfall	1992	9	3	745		3.7					
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2000	8	30	715	3.5	0.6	5	1.93	0.43	7.3	1.23
Poplar Bluff Lagoon Effluent	2000	8	30	1305	4.9	9.3	11	1.75	0.33	13	1.77
Main Ditch 0.5 miles below Poplar Bluff lagoon outfall	2000	8	30	655	3.5	1	19	1.52	0.6	21	2.64
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2000	8	30	1340		14	7	1.12	0.53	8.6	1.54
Main Ditch 0.5 miles below Poplar Bluff lagoon outfall	2000	8	30	1415		15	7	0.82	1.06	8.9	1.45
Pipe 32W, 3.4 miles below Poplar Bluff WWTP	2000	8	30	1447		9.6	3	0.37	0.47	3.8	0.68
Main Ditch 3.8 miles below Poplar Bluff lagoon outfall	2000	8	30	1447		9.6	3	0.37	0.47	3.8	0.68
Main Ditch 5.8 miles below Poplar Bluff lagoon outfall	2000	8	30	651	15	5	1	0.2	0.33	1.5	0.53
Pipe 32W, 3.4 miles below Poplar Bluff WWTP	2000	8	30	721	8.1	6.1	6	0.17	0.44	6.6	0.92
Main Ditch 3.8 miles below Poplar Bluff lagoon outfall	2000	8	30	721	8.1	6.1	6	0.17	0.44	6.6	0.92
Main Ditch 9 miles below Poplar Bluff lagoon outfall	2000	8	30	620	28	5.2	1	0.14	0.18	1.3	0.3
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	2000	8	30	620	0.2	4.3	0.5	0.02	0.025	0.5	0.04
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	2000	8	30	1435		7.7	1	0.02	0.025	1	0.03
Main Ditch 5.8 miles below Poplar Bluff lagoon outfall	2000	8	30	1407		19	3	0.02	0.19	3.2	0.56
Main Ditch 9 miles below Poplar Bluff lagoon outfall	2000	8	30	1344		13	2	0.02	0.13	2.1	0.37

Poplar Bluff Lagoon Effluent	2000	8	30	640		9.7					
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2000	8	31	710		0.6	4	1.94	0.43	6.3	1.22
Poplar Bluff Lagoon Effluent	2000	8	31	755		13	8	1.85	0.31	10	1.44
Main Ditch 0.5 miles below Poplar Bluff lagoon outfall	2000	8	31	725		1.3	10	1.6	0.55	12	1.79
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2000	8	31	1435		16	7	1.13	0.57	8.7	1.48
Main Ditch 0.5 miles below Poplar Bluff lagoon outfall	2000	8	31	1305		17	6	0.75	0.97	7.7	1.44
Pipe 32W, 3.4 miles below Poplar Bluff WWTP	2000	8	31	640		2.2	6	0.23	0.46	6.7	1
Main Ditch 3.8 miles below Poplar Bluff lagoon outfall	2000	8	31	640		2.2	6	0.23	0.46	6.7	1
Main Ditch 5.8 miles below Poplar Bluff lagoon outfall	2000	8	31	605		2.9	2	0.23	0.27	2.5	0.49
Pipe 32W, 3.4 miles below Poplar Bluff WWTP	2000	8	31	1405		18	3	0.19	0.62	3.8	0.94
Main Ditch 3.8 miles below Poplar Bluff lagoon outfall	2000	8	31	1405		18	3	0.19	0.62	3.8	0.94
Main Ditch 9 miles below Poplar Bluff lagoon outfall	2000	8	31	630		4.9	0.5	0.12	0.19	0.8	0.31
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	2000	8	31	740		4.3	0.5	0.02	0.025	0.5	0.03
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	2000	8	31	1250		6.6	0.5	0.02	0.025	0.5	0.03
Main Ditch 5.8 miles below Poplar Bluff lagoon outfall	2000	8	31	1325		19	3	0.02	0.25	3.2	0.59
Main Ditch 9 miles below Poplar Bluff lagoon outfall	2000	8	31	1350		14	2	0.02	0.13	2.1	0.31
Poplar Bluff Lagoon Effluent	2000	8	31	1145		9					
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	7	8	1830		16					
2nd pipe above M4, W bank	2002	7	9	925	0.4	5.1	18.4	14.7	0.05	18	0.02
Poplar Bluff Lagoon Effluent	2002	7	9	610		10	2.28	0.56	2.91	5.2	0.73
Poplar Bluff Lagoon Effluent	2002	7	9	1400		12	3.02	0.47	3	6	0.78
Main Ditch 0.5 miles below Poplar Bluff lagoon outfall	2002	7	9	635		2.2	1.62	0.4	2.46	4.1	0.54
Main Ditch 5.8 miles below Poplar Bluff lagoon outfall	2002	7	9	545		5.4	1.36	0.39	1	2.4	0.33
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	7	9	630		1.4	1.23	0.23	2.18	3.4	0.5
Main Ditch 0.5 miles below Poplar Bluff lagoon outfall	2002	7	9	1415		11	1.58	0.22	2.42	4	0.48
3rd pipe above M3, W bank	2002	7	9	1325	0.4	3.5	1.43	0.09	0.025	1.5	0.07
Main Ditch 5.8 miles below Poplar Bluff lagoon outfall	2002	7	9	1330		14	1.81	0.08	1.17	3	0.35
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	2002	7	9	1330		8.8	0.35	0.02	0.025	0.4	0.02
Pipe 32W, 3.4 miles below Poplar Bluff WWTP	2002	7	9	610		3.2	1	0.02	1.67	2.7	0.41
Main Ditch 3.8 miles below Poplar Bluff lagoon outfall	2002	7	9	610		3.2	1	0.02	1.67	2.7	0.41
Pipe 32W, 3.4 miles below Poplar Bluff WWTP	2002	7	9	1350		17	1.5	0.02	1.32	2.8	0.45
Main Ditch 3.8 miles below Poplar Bluff lagoon outfall	2002	7	9	1350		17	1.5	0.02	1.32	2.8	0.45
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	7	9	1410		10	1.66	0.02	2.26	3.9	0.51
1st pipe above M3, E bank	2002	7	9	1240	0.8	7.6	1.16	0.02	0.18	1.3	0.1
4th pipe above M4, W bank	2002	7	9	1005	0.8	5.9	0.25	0.02	0.025	0.3	0.07
1st pipe above M4, W bank	2002	7	9	820	1.2	5	0.36	0.02	0.025	0.4	0.08
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	2002	7	9	540		3.8	0.3	0.02	0.025	0.3	0.02

Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	7	9	615		1.4					
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	7	9	1430		12					
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	7	9	1645		6.5					
2nd pipe above M4, W bank	2002	7	10		0.3	3.9	11.6	9.96	0.09	12	0.02
Poplar Bluff Lagoon Effluent	2002	7	10			7.9	2.7	0.69	2.83	5.5	0.73
Poplar Bluff Lagoon Effluent	2002	7	10			15	2.31	0.67	2.89		0.85
Main Ditch 0.5 miles below Poplar Bluff lagoon outfall	2002	7	10			1.4	1.97	0.58	2.42	4.4	0.59
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	7	10			1.2	2.01	0.35	2.22	4.2	0.58
1st pipe above M4, W bank	2002	7	10		0.7	3.2	2.04	0.32	0.025	2.1	0.11
Main Ditch 0.5 miles below Poplar Bluff lagoon outfall	2002	7	10			12	1.79	0.23	2.43		0.52
Main Ditch 5.8 miles below Poplar Bluff lagoon outfall	2002	7	10			4.2	1.11	0.18	0.85	2	0.32
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	7	10			9.8	1.31	0.17	2.14		0.66
3rd pipe above M4, W bank	2002	7	10		0.3	4.6	0.93	0.07	0.08	1	0.13
1st pipe above M3, E bank	2002	7	10		0.3	1.9	1.26	0.06	0.025	1.3	0.12
3rd pipe above M3, W bank	2002	7	10		0.9	2.6	1.14	0.05	0.025	1.2	0.09
Pipe 32W, 3.4 miles below Poplar Bluff WWTP	2002	7	10			2.9	1.45	0.02	1.57		0.47
Main Ditch 3.8 miles below Poplar Bluff lagoon outfall	2002	7	10			2.9	1.45	0.02	1.57		0.47
Main Ditch 5.8 miles below Poplar Bluff lagoon outfall	2002	7	10			14	1.18	0.02	0.96		0.36
Pipe 32W, 3.4 miles below Poplar Bluff WWTP	2002	7	10			18	1.58	0.02	1.42		0.44
Main Ditch 3.8 miles below Poplar Bluff lagoon outfall	2002	7	10			18	1.58	0.02	1.42		0.44
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	2002	7	10			9.2	0.31	0.02	0.025		0.05
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	2002	7	10			3.6	0.3	0.02	0.025	0.3	0.02
1st pipe above M2, W bank	2002	7	10		0.9	6.2	1.3	0.02	0.025	1.3	0.18
2nd pipe above M3, E bank	2002	7	10		0.6	5.5	0.63	0.02	0.025	0.7	0.02
4th pipe above M4, W bank	2002	7	10		0.8	5.4	0.1	0.02	0.025	0	0.02
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	2002	8	5	800		8.3					
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	2002	8	5	1930		8.8					
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	8	5	1300		6.7					
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	8	5	1815		17					
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	8	6	600		1	2.76	1.42	2.26	5	0.8
Main Ditch 0.5 miles below Poplar Bluff lagoon outfall	2002	8	6	645		0.5	2.49	1.12	2.5	5	0.77
Poplar Bluff Lagoon Effluent	2002	8	6	630		3.5	3.1	1.12	2.45	5.6	0.83
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	8	6	1255		9.3	2.08	0.94	2.18	4.3	0.71
Poplar Bluff Lagoon Effluent	2002	8	6	1325		7.6	3.43	0.86	2.64	6.1	0.83
Main Ditch 0.5 miles below Poplar Bluff lagoon outfall	2002	8	6	1350		10	3.37	0.62	2.8	6.2	0.81
Pipe 26W, 2.6 miles below Poplar Bluff WWTP	2002	8	6	855		8	0.8	0.32	0.25	1.1	0.07
Main Ditch 5.8 miles below Poplar Bluff lagoon outfall	2002	8	6	710		3.3	1.28	0.24	1.2	2.5	0.43

Pipe 28W, 2.9 miles below Poplar Bluff WWTP	2002	8	6	930		7.3	0.73	0.17	0.38	1.1	0.07
Pipe 32W, 3.4 miles below Poplar Bluff WWTP	2002	8	6	1345		14	1.51	0.14	1.4	2.9	0.5
Main Ditch 3.8 miles below Poplar Bluff lagoon outfall	2002	8	6	1345		14	1.51	0.14	1.4	2.9	0.5
Pipe 32W, 3.4 miles below Poplar Bluff WWTP	2002	8	6	1045		7.2	0.92	0.13	0.6	1.5	0.1
Main Ditch 3.8 miles below Poplar Bluff lagoon outfall	2002	8	6	1045		7.2	0.92	0.13	0.6	1.5	0.1
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	2002	8	6	1300		6	0.63	0.02	0.025	0.7	0.06
Pipe 17W, 1.3 miles below Poplar Bluff WWTP	2002	8	6	740		5.1	0.88	0.02	0.025	0.9	0.09
Pipe 19E, 1.9 miles below Poplar Bluff WWTP	2002	8	6	820		7	0.62	0.02	0.07	0.7	0.07
Pipe 18W, 1.9 miles below Poplar Bluff WWTP	2002	8	6	820		7	0.62	0.02	0.07	0.7	0.07
Pipe 19E, 1.9 miles below Poplar Bluff WWTP	2002	8	6	810		8.3	0.49	0.02	0.26	0.8	0.15
Pipe 18W, 1.9 miles below Poplar Bluff WWTP	2002	8	6	810		8.3	0.49	0.02	0.26	0.8	0.15
Pipe 53W, 3.0 miles below Poplar Bluff WWTP	2002	8	6	1025		7.8	0.24	0.02	0.025	0.3	0.02
Pipe 46E, 4.9 miles below Poplar Bluff WWTP	2002	8	6	1145		7.5	0.39	0.02	0.025	0.4	0.08
Main Ditch 5.8 miles below Poplar Bluff lagoon outfall	2002	8	6	1415		19	2.75	0.02	0.92	3.7	0.5
Pipe 32W, 3.4 miles below Poplar Bluff WWTP	2002	8	6	640		3.1	1.1	0.02	1.52	2.6	0.41
Main Ditch 3.8 miles below Poplar Bluff lagoon outfall	2002	8	6	640		3.1	1.1	0.02	1.52	2.6	0.41
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	2002	8	6	600		3.2	0.44	0.02	0.025	0.5	0.06
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	2002	8	6	800		2.8					
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	2002	8	6	2400		8.8					
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	8	6	530		0.8					
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	8	6	1315		10					
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	8	6	1515		6.6					
Poplar Bluff Lagoon Effluent	2002	8	7	600		1.5	3.61	1.36	2.44	6.1	0.93
Main Ditch 5.8 miles below Poplar Bluff lagoon outfall	2002	8	7	705		3.4	2.55	1.36	1.29	3.8	0.41
Poplar Bluff Lagoon Effluent	2002	8	7	1300		3.9	2.91	1.09	2.65	5.6	0.91
Main Ditch 0.5 miles below Poplar Bluff lagoon outfall	2002	8	7	625		0.5	2.76	1.07	2.59	5.4	0.86
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	8	7	600		1.1	2.47	1.07	2.03	4.5	0.68
Main Ditch 0.5 miles below Poplar Bluff lagoon outfall	2002	8	7	1350		13	2.19	0.37	2.93	5.1	0.75
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	8	7	1305		12	4.62	0.36	1.92	6.5	0.81
Pipe 32W, 3.4 miles below Poplar Bluff WWTP	2002	8	7	1335		16	2.28	0.07	1.3	3.6	0.54
Main Ditch 3.8 miles below Poplar Bluff lagoon outfall	2002	8	7	1335		16	2.28	0.07	1.3	3.6	0.54
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	2002	8	7	655		3.7	0.53	0.02	0.025	0.6	0.02
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	2002	8	7	1330		6.9	0.46	0.02	0.025	0.5	0.02
Pipe 32W, 3.4 miles below Poplar Bluff WWTP	2002	8	7	635		3.9	1.13	0.02	1.31	2.4	0.39
Main Ditch 3.8 miles below Poplar Bluff lagoon outfall	2002	8	7	635		3.9	1.13	0.02	1.31	2.4	0.39
Main Ditch 5.8 miles below Poplar Bluff lagoon outfall	2002	8	7	1410		17	2.88	0.02	0.75	3.6	0.5
Pipe 53W, 3.0 miles below Poplar Bluff WWTP	2002	8	7	920		7.8	0.1	0.02	0.025	0.1	0.02

Pipe 32W, 3.4 miles below Poplar Bluff WWTP	2002	8	7	855		7	0.49	0.02	0.27	0.8	0.18
Main Ditch 3.8 miles below Poplar Bluff lagoon outfall	2002	8	7	855		7	0.49	0.02	0.27	0.8	0.18
Pipe 45W, 4.8 miles below Poplar Bluff WWTP	2002	8	7	645		8.2	0.58	0.02	0.025	0.6	0.05
Pipe 36W, 4.0 miles below Poplar Bluff WWTP	2002	8	7	750		7.4	0.67	0.02	0.025	0.7	0.24
Pipe 37E, 4.0 miles below Poplar Bluff WWTP	2002	8	7	750		7.4	0.67	0.02	0.025	0.7	0.24
Pipe 36W, 4.0 miles below Poplar Bluff WWTP	2002	8	7	800		5.5	0.38	0.02	0.025	0.4	0.07
Pipe 37E, 4.0 miles below Poplar Bluff WWTP	2002	8	7	800		5.5	0.38	0.02	0.025	0.4	0.07
Pipe 30W, 3.5 miles below Poplar Bluff WWTP	2002	8	7	845		7.2	0.38	0.02	0.025	0.4	0.08
Pipe 26W, 2.6 miles below Poplar Bluff WWTP	2002	8	7	1015		8.1	0.22	0.02	0.025	0.2	0.02
Pipe 28W, 2.9 miles below Poplar Bluff WWTP	2002	8	7	945		7.8	0.34	0.02	0.14	0.5	0.02
Pike Creek 0.7 miles above Poplar Bluff lagoon outfall	2002	8	7	500		8.9					
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	8	7	215		8.7					
Main Ditch 1.5 miles below Poplar Bluff lagoon outfall	2002	8	7	1030		8.5					
Pipe 32W, 3.4 miles below Poplar Bluff WWTP	2002										
Main Ditch 3.8 miles below Poplar Bluff lagoon outfall	2002										